United States Patent [19]

Ashkin et al.

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[54] **METHOD FOR REQUESTING SERVICE BY A DEVICE WHICH GENERATES A SERVICE REQUEST SIGNAL SUCCESSIVELY UNTIL IT IS SERVICED**

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[21] Appl. No.: **132,121**

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Related U.S. Application Data

[62] Division of Ser. No. 765,396, Aug. 14, 1985.

[51] **Int. Cl.**[4] **G06F 13/14; G06F 13/38**

[52] **U.S. Cl.** **364/200**; 364/222; 364/240.8; 364/241; 364/245; 364/262.3; 364/284.3; 340/825.08; 340/825.52

[58] **Field of Search** ... 364/200 MS File, 900 MS File; 340/825.06, 825.07, 825.08, 825.5, 825.52

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[57] **ABSTRACT**

A method for requesting service by a device coupled to a host computer through a communication medium. The host computer sets a service request bit of the device to a first logical value to allow the device to produce a service request signal if the device requires servicing. The device determines that it requires servicing and the device sets an internal flag bit to a first logical value to indicate that the device requires servicing. The device monitors a command from the host computer to see if the command is addressed to the device. If the command is not addressed to the device and if the service request bit is set to a first logical value, then the device generates a service request signal on the medium after the command by holding the communication medium low for a first period of time. If the command is addressed to the device, if the device determines that the command is not a command that services the device, and if the service request bit is set to the first logical value, then the device generates a service request signal on the medium after the command by holding the medium low for the first period of time and performs the command. If the command is addressed to the device, if the device determines that the command is not a command that services the device, and if the service request bit is not set to the first logical value, the device performs the command without generating the service request signal. The steps including and following the step of the device monitoring a command from the host computer are repeated until the device receives a command addressed to the device that services the device.

4 Claims, 4 Drawing Sheets

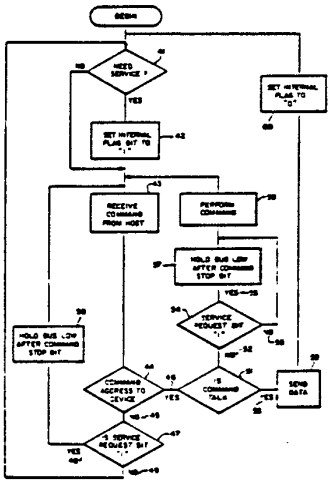

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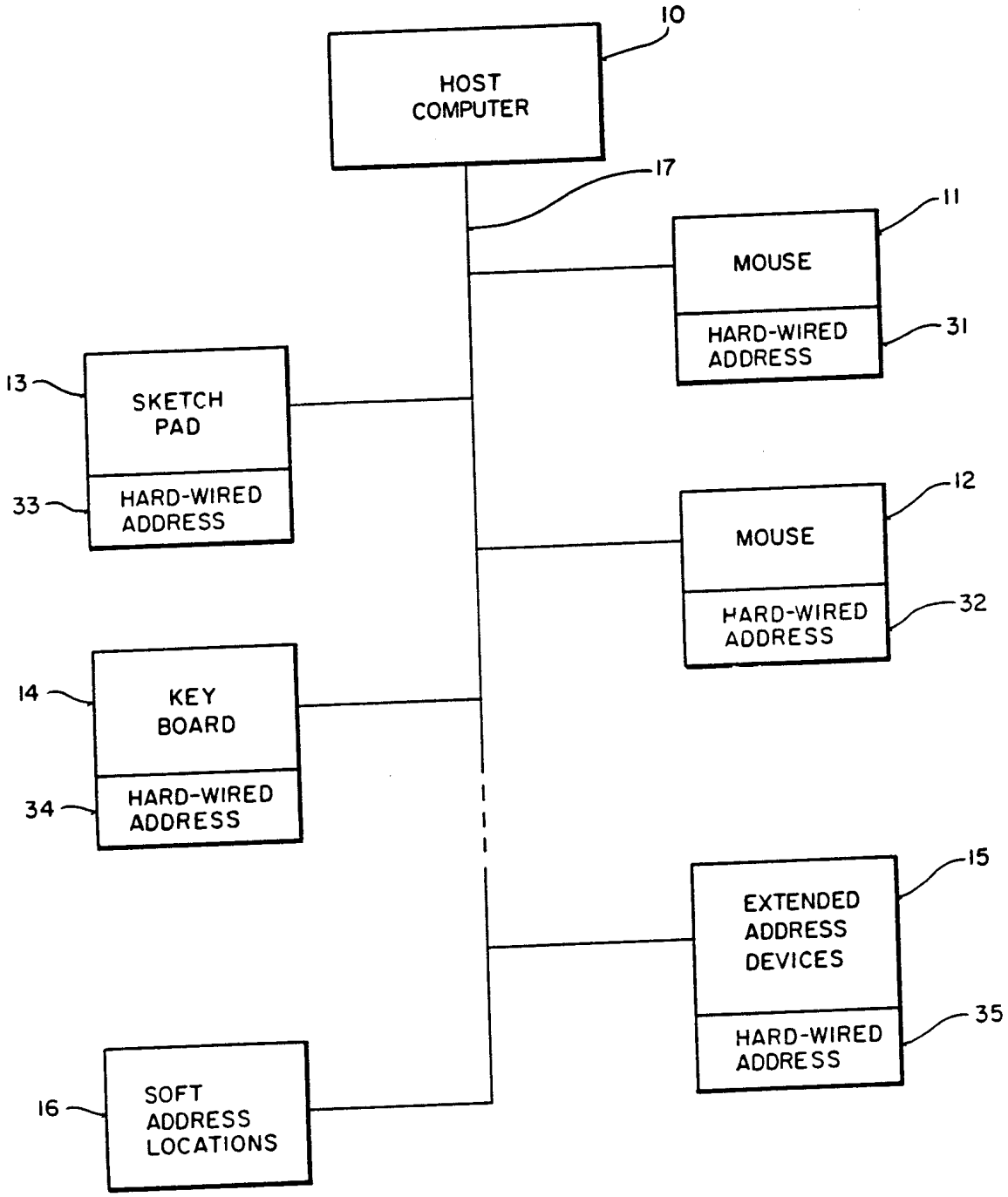
FIG_1



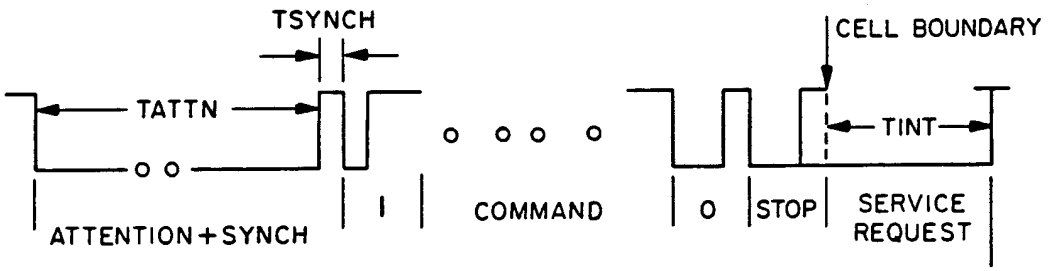


FIG 6

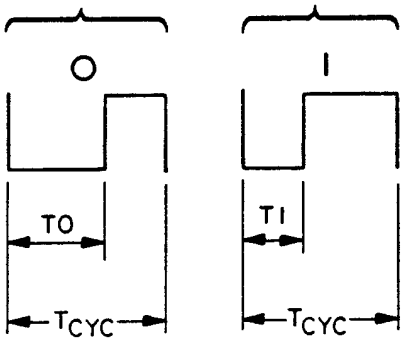


FIG 2

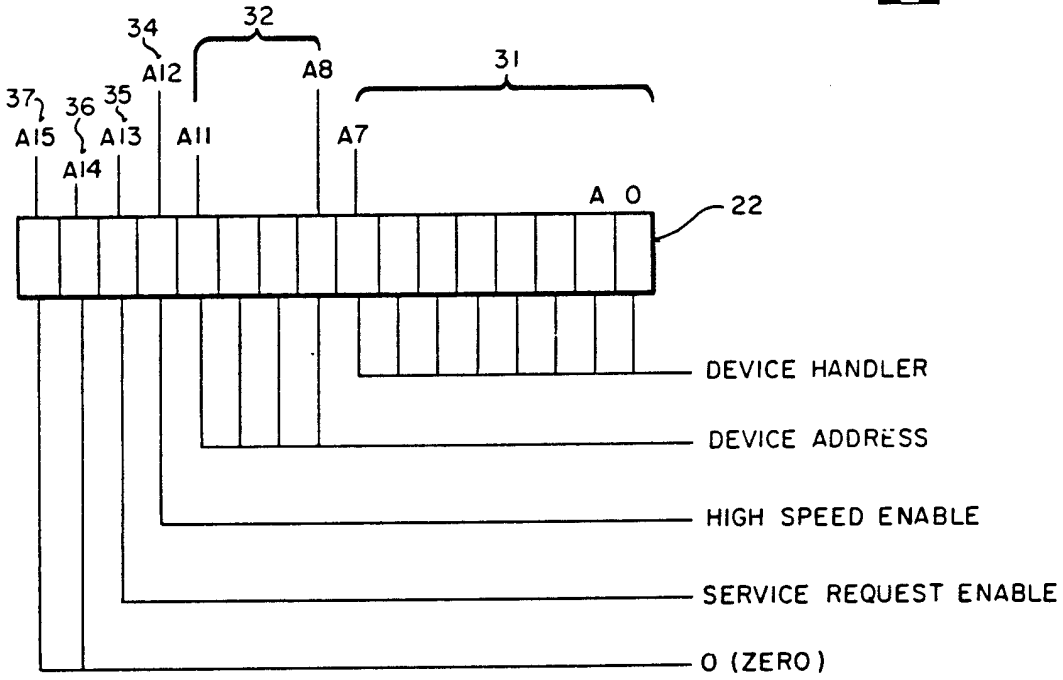


FIG 3

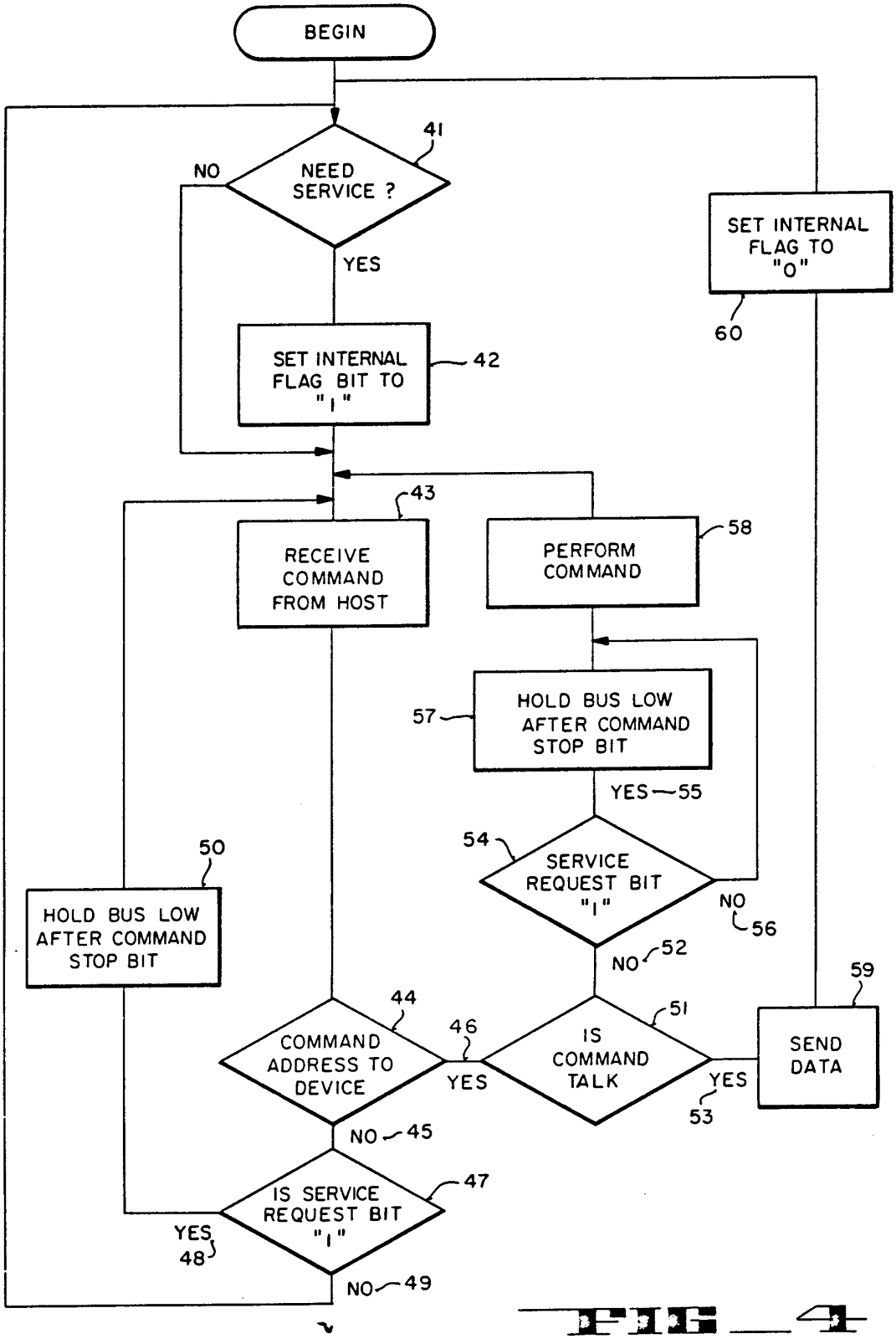

BEGIN
41
NEED SERVICE ?
NO
YES
SET INTERNAL FLAG BIT TO "1"
42
SET INTERNAL FLAG TO "0"
60
43
RECEIVE COMMAND FROM HOST
58
PERFORM COMMAND
57
HOLD BUS LOW AFTER COMMAND STOP BIT
YES
55
54
SERVICE REQUEST BIT "1"
NO
56
NO
52
50
HOLD BUS LOW AFTER COMMAND STOP BIT
44
COMMAND ADDRESS TO DEVICE
46
YES
51
IS COMMAND TALK
YES
53
59
SEND DATA
NO
45
47
IS SERVICE REQUEST BIT "1"
YES
48
NO
49

FIG. 4

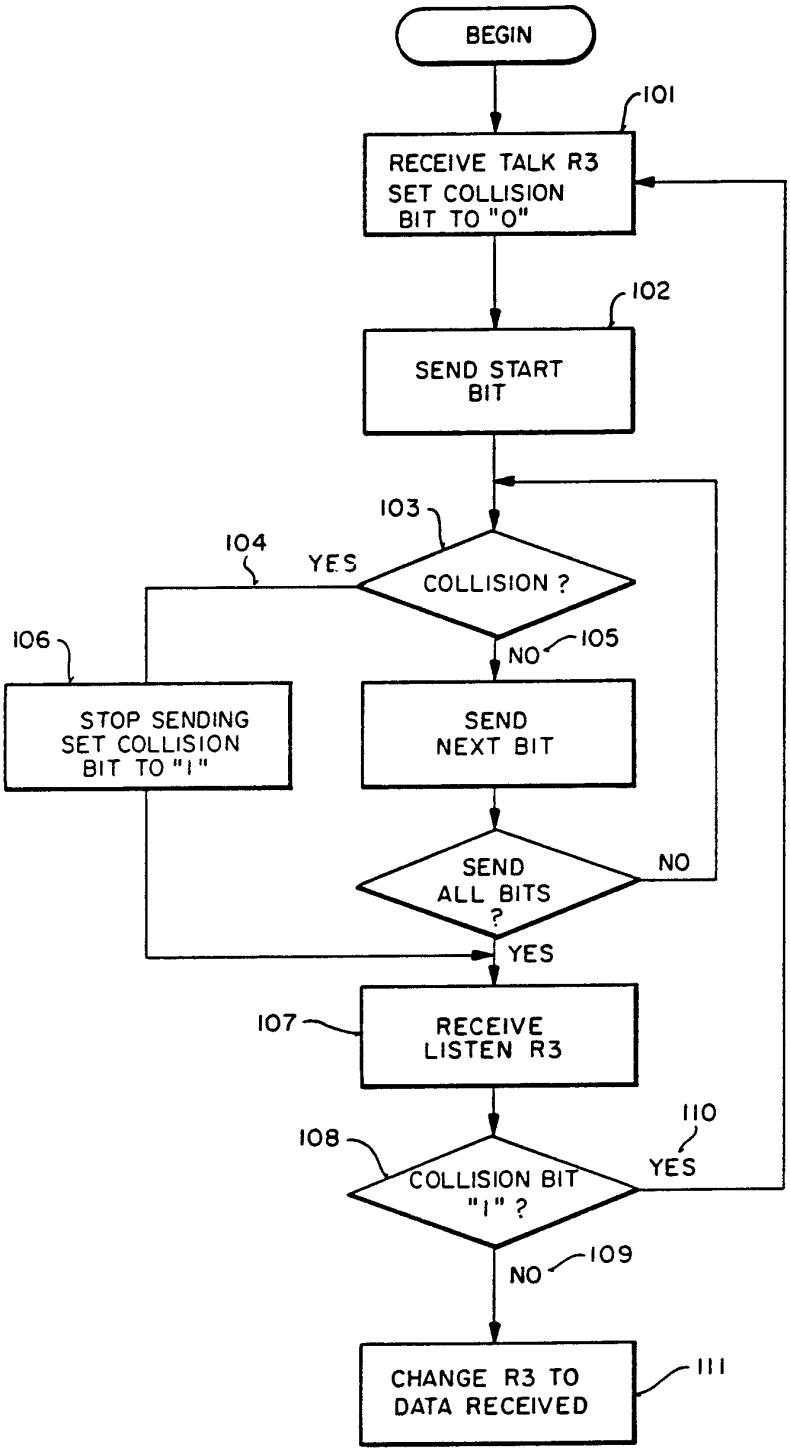

BEGIN
101
RECEIVE TALK R3
SET COLLISION
BIT TO "0"
102
SEND START
BIT
103
104
YES
COLLISION ?
NO
105
106
STOP SENDING
SET COLLISION
BIT TO "1"
SEND
NEXT BIT
SEND
ALL BITS
?
NO
YES
107
RECEIVE
LISTEN R3
108
110
COLLISION BIT
"1" ?
YES
NO
109
CHANGE R3 TO
DATA RECEIVED
111

FIG. 5

METHOD FOR REQUESTING SERVICE BY A DEVICE WHICH GENERATES A SERVICE REQUEST SIGNAL SUCCESSIVELY UNTIL IT IS SERVICED

This is a division of application Ser. No. 765,396 filed Aug. 14, 1985.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates the field of communications media for transferring data between a source and a plurality of peripheral devices coupled to the source. More particularly, the present invention relates to data transfer along a peripheral device bus between a plurality of peripheral devices and a host computer.

2. Art Background

In the computing industry, it is quite common to transfer data and commands between a plurality of data processing devices, such as for example, computers, printers, memories and the like. The interconnection of computers and other peripheral devices principally developed in the early 1970's with the advent of computer networking systems, which permitted the distribution of access to computing resources beyond the immediate proximity of a main frame computer.

Networks, such as the ARPA network, were developed to provide access by various users to large time-sharing systems and the transfer of data between such systems. In the case of geographically local networks, so-caled "local area networks" (LANs) were developed to connect together a collection of computers, terminals and peripherals located, typically in the same building or adjacent buildings, and permitted each of these devices to communicate among themselves or with devices attached to other networks. Local area networks permit the implementation of distributed computing. In other words, some of the devices coupled to the local area network may be dedicated to perform specific functions, such as file storage, data base management, terminal handling, and so on. By having different machines perform different tasks, distributed computing can make the implementation of the system simplier and more efficient.

Presently, networking has only been applied to provide communications between data processing devices, which are machine input devices. However, it would also be useful to provide a networking means to provide communication between a single computer and a plurality of peripheral devices such as human input devices, listen only devices, appliances, etc. Human input devices include keyboards, cursor control devices (such as a "mouse"), and sketch pads, etc. Listen only devices include transaction logs, etc. In the prior art, such devices are attached to a host computer through a port dedicated to each device. Often, additional "cards" are required to allow a peripheral input device to be added. Further, the addition of cards requires that the host computer be powered down, with no mechanism for adding peripheral devices to a live system. Such prior art systems are inefficient since peripheral devices are not generally operated simultaneously. (for example, someone using a mouse is generally not using the keyboard or sketchpad at the same time). Thus, the devices should share a common line to the host computer without creating data traffic problems, eliminating the need for cards.

Prior art networking schemes also include elaborate methods for establishing control of the network to allow a device to transmit. Such systems are not needed for networking of peripheral devices, since only one is generally used at a time. In addition, prior art networking schemes provide for means for attached devices to identify themselves to each other through elaborate "handshaking" schemes. Again, such complexity is not required to connect peripheral devices since there is no need for these devices to identify themselves to other devices, only to the host computer.

Therefore, it is an object of the present invention to provide a communications medium for a plurality of peripheral devices, which provides a simple and efficient means for coupling those devices to a host computer.

It is a further object of the present invention to provide a communications medium by which all such peripheral devices can be coupled to a host computer at a single input.

It is still another object of the present invention of provide a communications medium which provides a means for peripheral devices to indicate a need for servicing to the host computer.

It is yet another object of the present invention to provide a communications medium which provides a means for determining if the communications medium is in use.

It is another object of the present invention to provide a communications medium which allows peripheral devices to be added during operation of the system.

SUMMARY OF THE INVENTION

A communications medium is disclosed including apparatus and methods for transferring data between a plurality of peripheral devices and a host computer. In the preferred embodiment, a plurality of peripheral devices such as human input devices (including mice, keyboards, sketchpads, etc.), appliances, listen only devices, etc., are coupled to a common cable for data transmission and reception of commands. A peripheral device coupled to the cable may signal the host computer when it requires servicing. This peripheral device will continue to request service until the host computer commands it to transmit its data. All peripheral devices of the same generic type (e.g., all keyboards), may have an identical hard wired address used as an identification number. In this manner, the host computer can identify the generic type of device communicating on the cable. If more than one of the same type of device is coupled to the cable (e.g., 2 mice), the host computer will assign new addresses in the status registers of the mice so they can be differentiated.

In the preferred embodiment, a return to zero modulation scheme is used to transmit data and commands over the cable. As a result, a peripheral device will assume a collision if it attempts to transmit a high signal on the cable and the cable is pulled low by another device. In order to simplify the protocol of the system, only the computer can initiate communication.

The present invention permits the addition of peripheral devices to a computer while the computer is in use, without the need to power down the computer system. The present invention can be embodied in a narrow band medium, as well as broad band, fiber optic, infrared and other media.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is block diagram illustrating the networking system of the present invention.

FIG. 2 is a timing diagram illustrating the present invention's use of return to zero encoding.

FIG. 3 illustrates a register of a peripheral device of the present invention.

FIG. 4 is a flow chart illustrating the sequence of operations utilized by a peripheral device to request service by the host computer.

FIG. 5 is a flow chart illustrating the sequence the operations utilized to provide new addresses to devices sharing the same hard-wired address.

FIG. 6 is a timing diagram illustrating a command transaction of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A peripheral device bus including apparatus and methods for transferring data between a plurality of peripheral devices coupled to a host computer is disclosed. In the following description numerous specific details are set forth, such as specific numbers, registers, addresses, times, signals, and formats, etc., in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known circuits and devices are shown in block diagram form in order not to unnecessarily obscure the present invention.

Referring to FIG. 1, the preferred embodiment of the present invention may be seen. A plurality of peripheral devices, generally identified by numbers 11 through 16 are coupled through a single cable 17 to a host computer 10. In the preferred embodiment, all devices communicate with the host computer by a mini-phono jack with the following connecter assignments; tip-power, ring-data, sleeve-power return. A "high" signal (1) is 2.4 volts minimum. A "low" signal (0) is 0.8 volts maximum. Although a single cable is contemplated in the preferred embodiment of the present invention, other communications media, such as broad band methods, fiber optic systems, and infrared signals, are contemplated.

The bus of the present invention supports coded devices (for which a keystroke represents a symbol or a function, such as a keyboard 14), relative devices (in which movement of a display cursor in response to a control device, such as a mouse 11 or 12, may be from any starting point), and absolute devices (for which there is a constant and direct relationship between display position and device position, such as sketch pad 13).

The system also permits the networking of extended address devices. Extended address devices share a common hard wired address 35, but further include an address unique to the individual device which the host computer must recognize before the device can be accessed. For example, it is contemplated that appliances may be coupled to the host computer and controlled by the host computer. In such a situation, all appliances would have an identical hardwired fixed address. The host computer, on a first level, would simply address the hard wired address for appliances. At this time, all appliances coupled to that address are inactive. An individual appliance may be activated by the host computer if the host computer sends a signal to that appliance which matches the extended address of the appliance. An extended address is an individual identification number, which, in the preferred embodiment, may be up to 64 bytes long. Once the host computer has provided the extended address, the device having that address is active. Subsequent commands to the appliance address location will be executed by that device without the need for providing the extended address each time. An activated appliance will respond to all commands to the appliance address, while unactivated devices remain passive. To deactivate an active extended address device, the host computer provides the extended address of another extended address device, activating it and deactivating the previously active device. It is contemplated that any device which would be controlled by the host computer is suitable for the present networking scheme, such as lights, ovens, sprinkler systems, phone answering machines, etc. It is contemplated that at least one other hardwired address for extended address devices be provided in the present system. Such an address would be used for system protection schemes or user identification schemes. For example, a device at this location could contain an extended address which must be provided by the system user before the system could be enabled. In other instances, individual operations could require that the extended address of other security devices be provided by the host computer prior to performance. Such security devices could function as "keys" to lock the entire system or certain operations performed on the system.

Also reserved for use on the network of the present invention are soft address locations 16. Soft address locations are reserved for duplicates of peripheral devices coupled to the bus. When more than one mouse is coupled to the bus, for example, the host computer assigns new addresses to each mouse, those addresses being at the soft address locations.

Although specific examples have been given for each type of device coupled to the bus, there may be more than one kind of each type of device with that address. For example, a sketch pad has been given as an absolute device but a touch screen would also be considered an absolute device and be assigned the same fixed command address as the sketch pad. In those situations, the host computer will assign new addresses from the soft address locations to each device.

In the preferred embodiment of the present invention, the various peripheral devices have been assigned addresses as shown below:

Address	Device Types	Example
0000 (zero)	extended address device	security systems, user ID
0001 (one)	extended address device	appliances
0010 (two)	coded devices	keyboard
0011 (three)	relative devices	mouse, track ball
0100 (four)	absolute devices	sketchpad, touch screen
0101 (five)	reserved	none
0110 (six)	reserved	none
0111 (seven)	reserved	none
1000 (eight)	soft addressed	duplicate peripheral devices
—	—	—
—	—	—
1111 (15)	soft addressed	duplicate peripheral devices

It will appreciated by one skilled in the art that other addresses may be assigned to these devices containing more or less bits than in the preferred embodiment. Fixed hard-wired addresses 31, 32, 33, and 34 are shown in FIG. 1 for mouse 11, mouse 12, sketch pad 13, and keyboard 14, respectively.

All peripheral devices have four registers in the preferred embodiment to receive data and send data. For each device, register 3 talk and register 3 listen have status information such as device address and handler information. The remaining registers are data registers which are device specific except register 2 listen which contains the extended addresses for extended address devices or device specific contents for soft addressed devices.

In the preferred embodiment of the present invention, there are three types of communication on the peripheral bus; commands, data and global signals. Commands are sent from the host computer to the peripheral devices, data is sent from the host computer to the devices or from the devices to the host computer, and global signals are special messages sent to the entire system.

In the preferred embodiment data is encoded as the ratio of low time to high time of each bit cell. A bit cell boundary is defined by a falling edge on the bus. A "zero" is encoded as a bit cell in which the low time is greater than the high time. This is shown in FIG. 2 by bit cell 20. Therefore, a "1" is defined as a bit cell in which the low time is less than the high time as shown by cell 21 of FIG. 2. In the present preferred embodiment, a start bit is defined as a "1". A stop bit is a "0" which does not have an additional falling edge to define the bit cell time. The stop bit is used to synchronize the stopping of transactions on the bus.

The period for each bit cell of command signals and low speed data transmission is approximately 100 microseconds plus or minus 30%. For high speed data transmission, the bit cell is 50 microseconds plus or minus 1%. The format of a data transaction is a start bit (1), followed by up to 256 bits of data and ending with a stop bit. It will be appreciated that when other communications media are utilized, other signaling methods may be utilized.

Commands are sent only by the host. In the preferred embodiment of the present invention, there are three commands; talk, listen, and flush. As shown in FIG. 6, to signal the start of a command, an attention pulse is sent out. An attention pulse is generated by the host computer by transmitting a bus low for a period of "T-attn". In the preferred embodiment, T-attn is approximately 560–1040 microseconds. The attention pulse is followed by a synch pulse to give the initial bus timing. The following edge of the synch pulse is used as a timing reference for the first bit of the command. The command is followed by a stop bit, (in the preferred embodiment a "0"). After the stop bit, the bus returns to its normally high state unless a device requests service.

The command is an 8 bit value in the preferred embodiment. The command includes a 4 bit device address field which specifies the fixed hardwired address of the desired peripheral device (e.g., 0011 for a mouse). The next 2 bits form the command and the final 2 bits form a register address field which allows a specific register, R0–R3 within an addressed peripheral device to be specified. In the preferred embodiment, the commands have the following bit code:

Command	Code
Flush	01
Listen	10
Talk	11

The talk command orders the addressed device to provide its data to the host computer. The listen command orders the addressed device to accept data from the host computer and place it in one of its registers. The flush command has an effect on each device which is defined by the individual device. It can be used for such functions as clearing a register or resetting all keys on a keyboard so that they will be sent again.

When a peripheral devices is addressed to talk, it must respond within a certain period, called the "time out" period. The time out, "T1t", is approximately 140 to 260 microseconds (2 bit cells). The selected device, if it does not time out, becomes active on the bus and performs its data transaction, and then "untalks" itself and goes inactive on the bus.

Global signals are used for transactions which are neither commands nor data transactions. Global signals include: attention and synch, which is used to signal the start of a command and to give initial bus timing; service request, a transaction that devices use to signal the host that they require service; and reset, used to issue a break on the bus by holding the bus low for a minimum of "Tres", which is approximately 2.8 to 5.2 milliseconds, (40 bit cells). Global signals will be described in more detail in conjunction with other transactions.

Since a peripheral device can only send data when it has been commanded to talk by the host computer, the present system provides a means for a device to notify the host computer that it needs servicing. This is accomplished by having the device send a service request signal to the host computer. In the present invention, a service request is sent by holding the bus low after the stop bit of any command transaction. Each of the peripheral devices coupled to the bus include a number of registers (in the preferred embodiment four registers). FIG. 3 shows one of the registers for a peripheral device. Bit A13 has been identified as the service request enable bit. When this bit is set high by the host computer, the device is enabled to hold the bus low after the stop bit of a command transaction, as shown in FIG. 6, if the device needs service. A device will keep requesting service until it receives a talk command from the host. The flow chart in FIG. 4 shows the steps followed by a device requiring service.

Initially the device determines if it requires servicing, Block 41, that is, if it has data to send to the host. If it does, it sets an internal flag bit, Block 42. When the next command is sent out from the host, Block 43, the device checks to see if the command is addressed to the device, Block 44. If the command was not adddressed to the device Branch 45, the device checks to see if its service request enable bit, (bit A13 of register 3), is set high, Block 47. If so, Branch 48, it holds the bus low after the command stop bit, Block 50. (See FIG. 6) The device then waits until the next command is received from the host to see if it will be addressed to talk, Block 43. If the command is addressed to the device, Branch 46, the device determines if it is a command to talk, Block 51. If it is not a command to talk, Branch 52 the device sends a service request, Block 57, performs whatever command is instructed, Block 58, and awaits the next

command, Block 43. If the command is to talk, Branch 53, the device sends its data, Block 59, and considers its service request to be satisfied, Block 60. The device continues to monitor itself to determine when it needs service, Block 41. By allowing the host computer to control the service request enable bit, more efficient operation of the bus is realized. When a service request is received, the host computer need only ask those devices whose service request bit was enabled whether they need servicing. Additionally, the host computer can disable certain devices that are not required for particular applications.

When sending data, the device is able to detect collisions. If a peripheral device tries to output a 1 and the data line is or goes to a 0, the device assumes it has lost a collision to another device. This means that another device is also sending on the bus. When this happens the losing device untalks itself from the bus and preserves the data which was being sent for retransmission. The device sets an internal flag bit if it loses a collision. Prior art peripheral devices were unable to detect collisons. This novel feature of the present invention permits more efficient operation of the communications medium. By having the device sense a collision, it can preserve the data that is transmitted and indicate to the host computer that it requires serving. Additionally, the collision detection scheme of the present invention does not require a waiting period before a collision is assumed. A device will end its transmission if the line is modulated by another device or simply not begin its transmission if the line is already in use. Further, this collision detection scheme is useful in locating multiple devices at a single hardwired address location, such as mouse 11 and mouse 12 of FIG. 1.

In such a situation, the host will change the address of the devices by forcing a collision of devices sharing the same address. The host achieves this by issuing a talk R3 command addressed to those devices. As shown in FIG. 3, Register 3 22 (one of the registers of the device) contains the following information. Bits A0 through A7 31 contain a device handler which tells the host computer the function of a device and the use of data provided by the device. Bits A8 through A11 32 are an address field which can be changed when more than one device, having the same command address, is coupled to the bus. In that situation, one of the soft address locations are assigned to bits A8 through A11 32 which then serve as the command address for that device. Until that time, those bit locations contain a random number which aids in the detection of collisions. For example, if two mice received a talk R3 command and both began talking at the same time, neither would detect a collision. However, by having random numbers in the address field 32 of register 3 22, the output of the two devices will eventually differ. When that occurs, one of the devices will detect a collision and stop talking. Bit A12 34 is a high speed enable bit which if set, provides for data transmission at the higher modulation rate (50 microseconds per bit frame). The high speed enable bit is set by the host computer. If the host computer is unable to receive data at the higher modulation rate, it sets the high speed enable bit low in each of the devices. If the host computer is able to accept data at the higher modulation rate, and the device is able to transmit at the higher rate, (that information being contained in the handler bits 31 of register 3), the host computer sets the high speed enable bit 31 high for the device. As previously mentioned, bit A13 35 is service request enable which is set by the host to enable the device to perform a service request transaction. Bits A14 36 and A15 37 are reserved for future use and are set to 0.

When a device receives a talk R3 command the device provides its status (handler and address) to the host computer. If there are two devices of the same type coupled to the bus, only one can respond since the other will detect a collision. FIG. 5 shows the method of assigning new addresses on the bus.

After receiving a talk R3 signal, Block 101, the device sends its status from Register 3. If the line goes low, the device determines that there has been a collision, Branch 104, it stops sending (untalks itself) and sets and internal flag bit to indicate a collision, Block 106. The host sends a listen R3 to the mouse address, Block 107. Each commend resets the internal collision flag of the device. The device checks to see if its collision bit is set, Block 108. If the collision bit is not set, Branch 109, the device changes A8 through A11 to the soft address provided by the listen R3 command, Block 111. In this manner the address of the winning device is changed with the host computer keeping track of the new address of the device. If a collision bit is detected by the device after a listen R3 command, Branch 110, the device does not change the soft address bits, but may change other fields in R3. The host computer sends out another talk R3 command, Branch 101 to see if any devices remain at the mouse address. In this situation the remaining mouse will send its start bit, Block 102, not detect a collision, Branch 105, and send its status from register 3, Block 112. The host computer will send back a listen R3 command to the mouse address, Block 107. The remaining mouse will not detect a collision bit being set in this instance, Branch 109 so it will change bits A8 through A11 of register 3 to the soft address received from the host computer, Block 111. The host computer then sends out another talk R3 command to the mouse address, Block 101. This time, since no mouse remains at that address, the bus is timed out and the host computer knows that it has assigned new addresses to each of the mice sharing the mouse address.

In one embodiment of the present invention, peripheral devices have a device on them to indicate activity called the activator. The activator can be a special key on a keyboard or a button on a mouse. When more than one of a device is coupled to the bus, the host computer can display a message requesting one of the devices to use the activator. The host can then issue a listen R3 command which will change the address of the device which is activated. In this manner individual devices can be located and assigned new addresses in multiuser applications.

Thus, a peripheral device bus has been described which allows a plurality of peripheral devices to be coupled to a host computer through a single port.

We claim:

1. A method for requesting service by a device coupled to a host computer through a communication medium, comprising the steps of:

(1) the host computer setting a service request bit of the device to a first logical value to allow the device to produce a service request signal if the device requires servicing;

(2) the device determining that it requires servicing and setting an internal flag bit to a first logical value to indicate that the device requires servicing;

(3) the device monitoring a command from the host computer to see if the command is addressed to the device;

(4) if the command is not addressed to the device and if the service request bit is set to the first logical value, then the device generating a service request signal on the medium after the command by holding the communication medium low for a first period of time;

(5) if the command is addressed to the device, if the device determines that the command is not a command that services the device, and if the service request bit is set to the first logical value, then the device:

(a) generating the service request signal on the medium after the command by holding the medium low for the first period of time and

(b) performing the command;

(6) if the command is addressed to the device, if the device determines that the command is not a command that services the device, and if the service request bit is not set to the first logical value, then the device performing the command without generating the service request signal;

(7) repeating steps 3, 4, 5, and 6 until the device receives a command addressed to the device that services the device.

2. The method of claim 1 for requesting service, wherein the first logical value is a logical one.

3. The method of claim 1 for requesting service, wherein the command that services the device is a talk command addressed to the device.

4. The method of claim 1 for requesting service, comprising the additional step of the device sending its data to the host computer after receiving the talk command addressed to the device.

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